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How Much Do Distortions Affect Growth?

William Easterly

Contrary to the traditional view that distortions of relative prices have modest effects, Easterly finds that distortions can greatly affect growth and welfare.

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Summary findings

Easterly presents a simple endogenous growth model (with two types of capital) that shows the sizable long-run effects on growth of distortionary policies. The model applies to many different types of distortions of relative prices common in developing countries — for example, price controls, black market exchange rates, and differential taxes and tariffs.

The model shows that distortions of relative input prices can greatly affect growth and welfare. The magnitude of the effect depends on the production elasticity of substitution. With high substitutability, the effects on growth and welfare, although possibly large, are bounded, no matter how high the rate of distortion.

Subsidizing inputs and investment goods can increase growth, even though it worsens welfare. But a subsidy to one capital good financed by a tax on another capital good unambiguously reduces growth.

Empirical results show strong negative effects from variance in the relative prices of investment goods across sectors, while also confirming and extending earlier results showing that penalizing investment goods and distorting financial markets reduce growth.

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HOW MUCH DO DISTORTIONS AFFECT GROWTH?*

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I. INTRODUCTION

The economic literature on developing countries has long contained arguments that the large growth differentials among these countries could be explained by policy differences. Policies that directly distort relative prices and resource allocation -- such as tariffs, import quotas, controls on prices and interest rates, and discriminatory taxes -- have been particularly singled out to explain differential performance of developing countries (Balassa (1985), Krueger (1978, 1983), Chenery et al. (1986)).

However, according to the standard neoclassical growth model due to Solow (1956), distortionary policies affect only the level of income (and that modestly as dramatized by the famous Harberger triangles) and not its rate of growth. The alleged long-run growth effects of distortionary policy have also been dismissed in some "new" growth models (Lucas (1988) and Young (1991)). The natural conclusion is that distortionary policies are not that important in explaining large differences in economic performance (Rodrik (1991), Sachs (1987)).[1]

In contrast, authors such as Romer (1986, 1989), Barro (1990), Barro and Sala-i-Martin (1993), Jones and Manuelli (1990), and Rebelo (1991) have presented models in which policies have significant effects on long-run growth. For example, in the area of fiscal policy, Barro (1990) has discussed how tax rates can distort savings decisions and lower growth, while government services financed by those taxes can potentially raise private productivity and increase growth. A recent body of work has calculated the quantitative impact of tax policy on growth rates, with results that range from small (Lucas (1990)) to large (King and Rebelo (1990), Rebelo and Stokey (1993)) to very large (Jones, Manuelli, and Rossi (1993)).

However, the endogenous growth literature has so far not given much attention to the distortions of resource allocation commonly induced by policies in developing countries, including

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[1]The growth effects of distortionary policies could be preserved in the Solow model if we focused on the transition to the steady state. However, King and Rebelo (1993) have convincingly demonstrated that the Solow transition can explain very little of the long-run growth rate without generating counterfactual implications for the interest rate. Mankiw, Romer, and Weil (1992) generate a larger role for transitional dynamics by supposing a high capital share, including human capital.

both tax and nontax policies.[2] Tax systems in developing countries often have a very narrow base, because of widespread tax evasion and the small size of the formal sector (World Bank (1988)). Generation of revenue from this narrow base often implies very high tax rates. A few examples help illustrate this. More than 80 percent of income is said to go unreported in Argentina (ibid.). Employment in the private formal sector in Cote d'Ivoire amounts to only 1.4 percent of the population. Repeated attempts to increase tax revenue from the formal sector in Cote d'Ivoire have met with failure, as there is large-scale evasion of taxes -- which have an average effective tax rate of 48 percent (Chamley and Ghanem (1991)). Reliance on taxes on international trade is heavy in developing countries (particularly in Africa where it amounts to 35 percent of revenues), implying that the tax system penalizes the use of imported inputs in production (World Bank (1988)). Although tax distortions are also significant in industrial countries (King and Fullerton (1984)), these examples suggest another order of magnitude for developing country distortions.

Besides explicit features of the tax system, there are numerous other ways that governments in developing countries intervene to create large distortions of resource allocation. In addition to explicit taxes on trade, there are a host of other trade interventions frequently used, such as import quotas and licenses and multiple exchange rates, which imply distortions of prices of domestic versus foreign goods, as well as among different types of foreign goods (World Bank (1987)). Foreign exchange controls lead to the creation of black markets in foreign exchange, where the exchange rate is a large multiple of the official exchange rate. Prior to reforms in Ghana in 1983, for example, the black market exchange rate was 44 times the official rate (Islam and Wetzel (1991)). Government marketing boards pay prices to domestic producers of export commodities that are a small fraction of the international price.

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[2] An exception is Murphy, Shleifer, and Vishny (1991), which shows how rent-seeking in the presence of distortions can significantly lower growth

Controls on nominal interest rates often result in large negative real interest rates, while quantitative credit allocation rules imply large subsidies for some types of capital and heavy implicit taxes on others. For example, credit for mortgage lending in Turkey was neavily subsidized in the early 1980s, so that these borrowers paid highly negative real interest rates, while commercial credits for other types of loans carried real interest rates as high as 50 percent (World Bank (1989b)).

However, a large informal sector has sprung up side by side with the formal economy in many developing countries in response to distortionary government policies. De Soto (1989) has convincingly shown how government regulation led to a thriving informal sector in Peru. Over half of urban employment in Africa is said to be in the informal sector (World Bank (1989a)). The illegal economy in Ghana in 1982 was estimated to have accounted for 32 percent of GDP (Islam and Wetzel (1991)) The informal sector often seems to provide a cushion to soften the impact of even the most extreme government policies. The depredations of the Amin government in Uganda caused formal sector output to fall at 2 percent per year in 1970-78, but subsistence production continued to grow at 3.4 percent per year (Reynolds (1985)).

The multiple distortions described here often cause severe misalignment of relative prices. For example domestic prices of some goods will be driven up through exorbitant tariffs or restrictive quotas while others receive preferential tariff or quota treatment, or are held down by domestic price controls. The model in this paper will show that the distortion of composition of the aggregate capital stock resulting from such interventions can have large growth effects, just as the tax-induced distortion of the ratio of physical to human capital affects growth in Jones, Manuelli, and Rossi (1993) and Rebelo and Stokey (1993). The price distortions can be measured directly with the commodity-by-commodity price data collected by Summers and Heston (1988). This paper will propose a measure of relative price distortion relevant to long-run growth determination, and empirically examine its effects on growth.

The paper is organized as follows. Section II will present the basic model relating distortions to growth, and show how it covers a variety of common distortionary policies. Section III will present empirical testing of some of the implications of the model, deriving a new measure of the severity of distortion of the price system. Section IV concludes.

II. A MODEL OF ENDOGENOUS GROWTH WITH DISTORTIONARY POLICIES

This section presents an endogenous growth model that attempts to capture some of the special features of distortionary government policy in developing countries. It postulates a model of constant returns to scale in reproducible capital, as in Rebelo (1991) and Barro (1990).[3] Capital is broadly defined to include both physical and human capital. Two generic types of capital are defined to produce the single output -- the types will be initially interpreted as formal and informal sector capital. The distortion will be defined initially as a sales tax on investment purchases in the formal sector. The relationship between this distortion rate and growth will then be discussed. Applications to other policies will then be considered. Throughout the paper, we assume that the economy is insulated from international financial markets, although trade in goods is considered. While the model is highly stylized, the results seem to give insight into some of the developing country characteristics discussed above.

The Model

Equation (1) shows the production function for our analysis:

$$(1) \qquad Y = A\,(\gamma\, K_1^{\epsilon} + (1-\gamma)\, K_2^{\epsilon})^{\frac{1}{\epsilon}}$$

[3]This type of model can also be seen as a convenient approximation to a Solow model with a very high share of capital (including human capital), in which policies have such large level effects that they appear to be growth effects. Constant returns in reproducible capital allows the derivation of a steady state that approximates the transitional behavior of a Solow model with high capital share.

Output is a CES function of the two generic types of capital, with elasticity of substitution $1/(\epsilon-1)$. For simplicity, we assume population to be fixed throughout the analysis.

Initially we interpret the two types of capital as being formal and informal sector capital, which are defined in terms of their location, ownership, and visibility to the tax authorities. We assume that the two types of capital can both be formed from the domestic good with zero installation cost, and that the economy is closed both to foreign trade and capital flows (in the next section, we will show how some alternative interpretations do not change the model). The distortion is a sales tax on formal sector investment purchases, which informal sector investment purchases evade.

We assume that identical, infinitely-lived dynasties of producer-consumers maximize the present discounted value of the utility of future consumption:

$$(2) \qquad \int_0^\infty e^{-\rho t} \frac{C^{1-\sigma}-1}{1-\sigma}\, dt$$

Utility is given as an isoelastic function of total consumption C where the intertemporal elasticity of substitution is $1/\sigma$.

Consumption is given by the excess of income over investment spending:

$$(3) \qquad C = Y - (1+\tau) I_1 - I_2 + T$$

where τ is the rate of sales tax on purchases of investment goods of the first type. The variable T is the lump-sum transfer of tax revenues back to consumers, ex-post equal to τI_1, but treated by the consumer as fixed. Growth is unaffected, however, if the revenues are not rebated to the consumer. The equations of accumulation of capital are:

$$(4) \qquad \dot{K}_1 = I_1 - \delta K_1$$

$$(5) \qquad \dot{K}_2 = I_2 - \delta K_2$$

where δ is the rate of depreciation, assumed equal across capital types to simplify the algebra. We do not explicitly impose the condition that investment is irreversible.

The first-order conditions imply that the distortion will act as a wedge between the marginal products of the two types of capital, as follows:

$$(6) \qquad \frac{\frac{\partial Y}{\partial K_1}}{\frac{\partial Y}{\partial K_2}} = 1 + \tau$$

where τ is the rate of tax on investment in type 1 capital. This implies the following ratio of type 2 to type 1 capital (denoted Φ), from (1) and (6):

$$(7) \qquad \Phi = \frac{K_2}{K_1} = \left[\frac{(1-\gamma)(1+\tau)}{\gamma} \right]^{\frac{1}{1-\epsilon}}$$

The distortion τ induces more of type 2 capital to be held relative to type 1 capital than is socially optimal. The elasticity of substitution $(1/(\epsilon-1))$ determines how strongly the ratio of capital inputs will respond to increases in the distortion.

In steady state, consumption and output will grow at the same rate, which will be given by:

$$(8) \qquad g = \frac{r_2 - \delta - \rho}{\sigma}$$

where r_2 is the marginal product of type 2 capital, given by the following:

$$(9) \qquad r_2 = A(1-\gamma)\left(\gamma \Phi^{-\epsilon} + 1 - \gamma\right)^{\frac{1}{\epsilon} - 1}$$

and Φ is the ratio of K_2 to K_1 given by (7). Growth is given by the familiar condition that optimal growth of consumption is equal to the difference between the net marginal product of capital and the rate of time preference, times the intertemporal elasticity of substitution. Since the marginal product of type 2 capital goes down when the ratio of type 2 to type 1 capital increases, which occurs when type 1 capital is taxed more heavily, growth is unambiguously a negative function of the tax rate τ.

A policy equivalence that follows immediately is that between a sales tax and an income tax. An income tax on the income from formal sector capital that is evaded by holders of informal sector

capital will enter in an exactly analogous way as above (the income tax rate t equivalent to a sales tax τ is $t = \tau/(1+\tau)$).[4]

The nature of the relationship between growth and distortion depends on the production elasticity of substitution between the two types of capital. Figure 1 shows a simulation of growth rates for plausible parameter values with alternative production elasticities.[5] The graphs are shown in terms of the equivalent income tax. With a high elasticity of substitution in production, even an income tax rate close to unity could still permit positive per capita growth. This is because when the elasticity of substitution is greater than one, neither input is essential to production. As the tax rate approaches one, investment in type 1 capital asymptotically approaches zero. However, production is still possible relying only on type 2 capital, and so the rate of return to type 2 capital remains positive. While a high elasticity of substitution may seem implausible in a model with only two inputs, it is more plausible in a multiple input production function where many types of taxed capital goods will have close substitutes in the informal sector. A high elasticity of substitution between informal and formal capital could give insight into why even highly distorted economies could have less than catastrophic growth performance (such as Amin's Uganda, as cited earlier).

If the elasticity of production is less than or equal to one, then the level of output and the rate of return to type 2 capital go to zero as the tax rate approaches one. As the tax rate goes to unity, economic agents will decumulate capital (assuming no irreversibility in investment) at a rate $((\delta+\rho)/\sigma)$. Growth also falls off more steeply at lower levels of the tax rate, as shown in figure 1.

There is an analogous effect of the elasticity of substitution on the welfare loss associated with the distortionary tax. Figure 2 shows how the welfare loss is small at first, regardless of the

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[4]This equivalence is noted in another context by Atkinson and Stiglitz (1980).

[5]The parameter values used for the simulation are $A = .5$, $\delta = .05$, $\gamma = .5$, $\epsilon = 2/3$, $\sigma = 2$, and $\rho = .1$. These values are arbitrarily chosen to reproduce plausible ranges of growth rates for illustrative purposes. The shape of the growth-distortion relationship is robust to changes in these parameters except for the production elasticity of substitution (as discussed in the text) and the intertemporal elasticity of substitution (not discussed here, since it is well known to control the strength of the saving response to tax changes).

elasticity.[6] This follows from the fact that a laissez-faire zero tax policy is first-best, which must imply that the derivative of welfare with respect to the tax rate is zero at a zero tax rate. As the tax rate increases, welfare falls off more sharply in the high elasticity case, then bottoms out at a finite level as the tax rate goes to one. This occurs because the taxed input is inessential, so even elimination of the input's use only leads to a finite, albeit substantial, welfare loss. As the use of the input approaches zero, the marginal welfare loss of a higher tax on that input is minimal. In the low substitutability case, the welfare loss is not bounded since the taxed input is essential for production.

This idealized framework suggest that one's strategy in a highly distorted economy should be influenced by one's assumption about substitutability of inputs in the production function. If one believes substitutability is high, one should concentrate on large reductions in large distortions, since moderate reductions have little benefit -- a "Big Bang" is needed. If one believes substitutability is low, then any reduction in a large distortion will be beneficial -- "gradualism" is a viable strategy.

It is also apparent from the maximization problem above that a sales tax that applies only to consumption purchases will have no effect on growth.[7] With exogenous labor supply, investment price distortions lower growth, but consumption price distortions do not. Since this result will be tested in the empirical analysis, it is worth examining how it compares with others in the literature. Consumption taxes that are rebated lump-sum to consumers affect growth in the endogenous labor supply models of Rebelo and Stokey (1993) and Jones, Manuelli, and Rossi (1993) (with Lucas

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[6] Welfare in steady state can be calculated as:

$$W = \frac{(c_k K_0)^{1-\sigma}}{1-\sigma} \left(\frac{1}{\rho - g(1-\sigma)} \right)$$

where K_0 is the initial level of the total capital stock and c_k is the ratio of consumption to total capital stock, given as:

$$\frac{C}{K_1+K_2} = (r_2-\delta)\left(1-\frac{1}{\sigma}\right) + \frac{\rho}{\sigma} + \frac{r_2\tau}{1+\Phi}$$

[7] It can be shown, however, that taxes on intermediate goods act much like taxes on investment goods and so do affect growth.

(1988, 1990) "effective labor"). However, Rebelo and Stokey (1993) show that consumption taxes do not affect growth if they are not rebated to consumers.[8]

The fall in growth as a result of the tax on capital is similar to results obtained by Barro (1990), King and Rebelo (1990), and Jones and Manuelli (1990). What is different here is that the fall in growth occurs not only through a fall in investment, but also in the efficiency of investment. An increase in the distortionary tax rate will lower growth even for a fixed rate of total investment to output (defined as the sum of the two types of investment as a ratio to output). Rebelo and Stokey (1993) and Jones, Manuelli, and Rossi (1993) show related compositional effects of tax policy on the ratios of human to physical capital.

It is also apparent from (7)-(9) that a negative value of τ, i.e. a subsidy to investment in type I capital financed by lump-sum taxation, will raise growth. Although lump-sum taxation is unrealistic, this result would also occur with a subsidy to one type of investment financed by a tax on consumption, since the latter has no growth effect. This is an example of the well-known possibility of immiserizing growth, since welfare is worsened but growth increases due to the subsidy. It is still true, however, that a higher subsidy will lower growth for a given rate of saving and investment; the increase in growth comes about through higher investment, partially offset by lower efficiency of investment.

Self-financing subsidy and tax schemes

Thus far we have considered only policies that implicitly tax one form of capital, assuming the proceeds are dissipated in lump-sum transfers. Other policies have the character of taxing one

[8]This result is a consequence of the restrictions on the utility function required to generate a steady state growth path with a constant fraction of time devoted to leisure, which requires that income and substitution effects of wage changes cancel out, as pointed out earlier by King, Plosser, and Rebelo (1988). Rebelo and Stokey (1993) also show that if leisure is "quality-adjusted" (i.e. multiplied by the level of human capital), then consumption taxes do not affect growth regardless of whether the taxes are rebated or not.

type of capital and using the proceeds to subsidize another. For example, price controls act as a subsidy to the use of the controlled-price goods, implicitly financed by taxes on other goods.[9]

Using the framework of the previous section, we now assume investment in capital type 1 is taxed at rate τ, and that the proceeds are used to finance a subsidy to capital type 2 at rate s. The first-order condition (7) for the allocation of capital will be modified to be:

$$(11) \quad \Phi = \frac{K_2}{K_1} = \left[\left[\frac{1-\gamma}{\gamma} \right] \left[\frac{1+\tau}{1-s} \right] \right]^{\frac{1}{1-\alpha}}$$

The requirement that the scheme be self-financing imposes the condition:

$$(12) \quad \frac{K_2}{K_1} = \frac{\tau}{s}$$

For a given subsidy rate s, (11) determines the allocation of capital between types and (12) determines the tax rate necessary to finance the subsidy. The growth rate expression (8) will now be modified to be:

$$(13) \quad g = \frac{\frac{r_2}{1-s} - \delta - \rho}{\sigma}$$

An increase in the self-financing subsidy will have two offsetting effects on the growth rate. The increase in the subsidy makes accumulation of type 2 capital more attractive, and tends to raise growth, as in the previous section. However, the before-subsidy marginal product of type 2 capital will fall because of the substitution from type 1 to type 2 capital, which is induced by the subsidy and by the tax necessary to finance the subsidy. Appendix I shows that the second effect always outweighs the first: the net effect is that growth unambiguously falls with an increase in the rate of subsidy financed by a tax on capital.

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[9]This is presuming that the price controls are accompanied by budgetary transfers to compensate the producer for the lower price. Otherwise, shortages and black market prices arise, just as in the case of foreign exchange controls (see below).

Other policy applications

The analysis has been presented thus far in terms of a sales tax or subsidy (or equivalent income tax) on formal sector capital in the presence of an informal sector. We now show some other examples of policies that give similar results, illustrating that the framework is general enough to consider a range of distortionary policies.

1. Financial repression

Controls on interest rates below market levels generally lead to quantitative credit allocation by the formal financial system, combined with a flourishing "curb" market formed by consumers or producers who lend to each other at market rates. The quantitative credit allocation rules are often designed to promote certain kinds of activities, for example, small-scale enterprises or agriculture (World Bank (1989b)). In terms of this model, we can think of a credit subsidy being given to all who invest in a particular kind of capital goods (type 2 capital). We can assume that the subsidy is financed by an implicit tax on the non-subsidized capital (type 1 capital).

2. Trade policy

We could next redefine the two types of capital to be imported capital (K_1) and domestically produced capital (K_2), and redefine the tax rate τ as a tariff on imported goods. We assume that the domestic good is also traded internationally and that the country is a price-taker (the international price ratio of the two goods is fixed at unity for convenience). The tariff then acts as a tax on type 1 investment goods. Equally, both types of goods could be imported, and the tariff structure imply a tax-cum-subsidy scheme in favor of some types of investment goods. Thus, both a higher level and a greater dispersion of tariffs (or equivalent quotas) will result in lower growth according to this model.

3. Exchange rate policy

When exchange rate controls in developing countries lead to black markets in foreign exchange, foreign exchange is typically allocated at the official rate so as to favor certain activities.

In terms of this model, a foreign exchange allocation that grants foreign exchange at the official rates for goods that make up capital type 2, and does not grant any for investment in type 1 goods, will imply a tax-cum-subsidy scheme with the wedge between the two goods equal to the black market exchange rate premium.

4. Price controls

Price controls on particular goods are a common feature of developing country policies. For example, coal prices are often controlled to be below international levels in many countries (World Bank (1988)). The coal subsidy is financed by other revenues from the government budget. This is equivalent to the tax cum subsidy scheme discussed in the previous section. Since distortions 2. and 3. above also affect the price system, this suggests that a comprehensive measure is needed to capture all of the complicated and possibly offsetting relative price distortions inherent in government policies.

III. EMPIRICAL RESULTS

Although a large literature exists relating policy variables to growth, there have been few attempts to measure price distortions directly. This section proposes a new measure of relative price distortion and tests its relation to growth, along with other distortion measures used in other studies. We discuss first the variables, and then discuss the results.

Variables

1. *Price distortions*

One way to measure indirect distortions of prices, like those analyzed in the previous section, would be to look directly at observed retail prices across countries. Summers and Heston (1988) collected data on 1980 benchmark prices relative to the U.S. for 57 countries and 151 commodities.

We construct a measure of the variance of relative prices across commodities for each country and interpret this as a measure of overall distortion of the price system. There are two adjustments that need to be made. First, the variance of each commodity's price across countries due to differences in natural resource endowments needs to be removed. Although theoretically this is necessary only for nontraded commodities, even traded commodities' domestic price may contain a nontraded component due to retailing and transportation costs. This is done by isolating the orthogonal component of each of the log of the 151 prices with respect to per capita income. Secondly, the theory predicts that only distortions in prices of intermediate inputs and investment goods matter. We test this implication of the theory by computing separately cross-commodity variances for consumption goods and for investment/intermediate goods (human capital inputs such as health and education were also included under investment -- Appendix III contains the list of commodities). We use the same data to compute the expenditure-weighted mean of the orthogonalized logs of relative input/investment prices. We then compute for each country the expenditure-weighted sum of squared deviations of each commodity's orthogonalized log price from the log mean.[10]

Appendix II shows the variance and mean of input prices for each country. The countries with the highest variance of relative input prices in 1980 are Sri Lanka, Venezuela, Peru, Bolivia, and Indonesia. All of these countries partially compensate with cheap prices for inputs and investment goods. Cote d'Ivoire, Nigeria, Senegal, and Cameroon have the highest average input prices. Industrial countries generally have low distortions of relative input prices, and neither very high nor very low average input prices. Table 1 shows the mean and variance of these and the other distortion measures.

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[10]This is similar to the clever procedure followed by Aitken (1991) to compute a measure of distortion. However, Aitken aggregates commodities into 16 categories before computing cross-commodity variances, he does not distinguish between consumption and investment goods, and he does not relate his index to growth. I am grateful to Brian Aitken for supplying the Summers-Heston price data in convenient format.

Table 1: Descriptive statistics for distortion measures	Sample mean	Sample standard deviation	Number of countries in sample
Mean across input categories of log of ratio of input prices to U.S. price (orthogonal component to income), 1980	-0.230	0.458	57
Variance across input categories of log of ratio of input prices to U.S. price (orthogonal component to income), 1980	0.241	0.158	57
Mean across consumption categories of log of ratio of consumption prices to U.S. price (orthogonal component to income) , 1980	-0.160	0.333	57
Variance across consumption categories of log of ratio of input prices to U.S. price (orthogonal component to income), 1980	0.230	0.149	57
Log of ratio of black market to official exchange rate, average 1970-85	0.194	0.251	106
Average real interest rate, 1970-85 (used to define financial repression dummy)	-3.58	8.95	53

Earlier results for growth using the Summers and Heston price data were found by Dollar (1992) and De Long and Summers (1991). Dollar tested a measure of exchange rate overvaluation constructed as the average price level in each country relative to the US, corrected for differences in resource endowments, and found overvaluation to significantly lower growth. De Long and Summers found that high relative equipment prices significantly lower growth.

2. *Financial distortions*

We extend a dataset from Gelb (1989) of real interest rates for developing countries, adding observations for developed countries. A highly negative real interest rate is interpreted to imply the existence of nominal interest rate controls (moderately negative real interest rates have been observed for reasonably long periods even in countries with uncontrolled interest rates). We follow World Bank (1989b) in defining "financial repression" as an average real interest rate below -5 percent over 1970-85 (period varies depending on data availability) – there are 14 such countries (out of 53). We will examine robustness to other cutoff points as well as to the use of a continuous variable. Gelb (1989) found real interest rates to be significantly correlated with growth. Fischer (1983, 1991) and Kormendi and Meguire (1985) report a possibly related finding of a negative effect of inflation on growth.

3. *Black market premium*

The black market premium is defined as the log of the ratio of the black market to the official rate over roughly 1970-85 (period varies with data availability), based on data from Pick's Currency Yearbook and the World Bank. Levine and Renelt (1992) found this variable to have a significant effect on investment, although not on growth; Easterly (1991) found it to be a good predictor of whether countries are caught in a low-level equilibrium trap.

4. *Government consumption*

Government consumption has been found to be negatively related to growth by Barro (1991), Grier and Tullock (1989), Landau (1986), and Murphy, Shleifer, and Vishny (1991). In terms of the model in section II, government consumption is an indicator of high taxes on the formal sector.

5. *Barro correlates*

In addition to these measures of distortion of resource allocation, we also test for correlates reported by other studies, taking Barro (1991) as the benchmark study. We focus on initial income, primary enrollment, and secondary enrollment. We also use the same dependent variable (per capita growth 1970-85 from Summers and Heston (1988)) as Barro for ease of comparison. Finally, the investment rate (also from Barro/Summers and Heston) is added to the equation to test the implication of the model that distortions lower growth controlling for investment.

Empirical results

Table 2 shows the results. Both the mean input price and the variance of input prices across commodities are significant. The variance result is consistent with the prediction of the model in section II -- in a multiple input world, distortions of relative prices away from world prices will lower growth. The magnitude of the variance coefficient is such that increasing the variance of relative prices from the sample mean of .24 by one standard deviation to .40 will lower growth by 1.2 percentage points.

The significance of the mean input price is reminiscent of the De Long and Summers (1991) finding that cheap investment equipment is good for growth. Here we find more generally that cheap inputs -- including intermediate inputs, education, health, buildings and equipment investment -- are good for growth. This result confirms the prediction of the model that subsidizing inputs is a feasible way to raise growth (although immiserizing unless there are externalities). When the equipment price

variable is added, neither price is significant -- we cannot distinguish between the two -- but the variance of input prices continues to be significant (regression VI).

The financial repression dummy is also highly significant, with a coefficient indicating a loss of about 1.5 percentage points in growth due to financial repression. Th' does not appear to be a proxy for high inflation, which was insignificant when tested separately. The implicit taxes from highly negative real interest rates apparently fall on productive investment. If we accept regression I as a valid reduced form, these three distortion variables (with government consumption) explain half of the cross-section variance in growth rates.

The financial repression dummy, and the mean and variance of input prices continue to be significant when investment is added (regressions II and III). Growth falls for a given rate of investment falls when relative input prices are heavily distorted, when inputs are expensive, and when interest rates are repressed. The significance of the financial repression dummy and the variance of input prices confirms the efficiency effects predicted by the model in section II. The significance of mean input prices does not at first seem to conform to the prediction of the model that a uniform tax on all inputs should affect the level of investment, but not the efficiency of investment. However, since investment here includes only physical capital, the result may reflect higher productivity of physical capital with cheaper intermediate and human capital inputs.

Because investment is likely endogenous, we show also a regression (IIIa) with an instrumental variables estimator, using as instruments for investment the other right-hand side variables as well as continent dummies for Africa and Latin America, a dummy variable for oil producers, and the population size in 1960. The coefficient on investment is increased, but the coefficients on the other variables are roughly unchanged.

Table 2: Regression results, growth and distortion

Dependent variable: Per capita growth, 1970 85 (Summers and Heston(1988))

Regression:	Variable: Constant	Average of 1980 log input price	Variance of 1980 log input price	Government consumption	Financial repression dummy	Total investment	Mean of 1980 consumption price	Variance of 1980 consumption price	Mean of 1980 equipment price	Black market premium	Initial income, 1960	Primary enrollment, 1960	Secondary enrollment, 1960	R2/RBAR2	Number of observations
I	0.043	-0.024	-0.075	-0.058	-0.014									0.52	38
	(6.84)	(-2.67)	(-2.15)	(-1.58)	(-2.00)									0.46	
II	0.016	-0.026	-0.065	-0.031	-0.016	0.092								0.59	38
	(1.38)	(-3.05)	(-1.95)	(-0.76)	(-2.35)	(2.64)								0.53	
III	0.010	-0.027	-0.066		-0.016	0.098								0.59	38
	(1.02)	(-3.59)	(-2.18)		(-2.36)	(2.99)								0.54	
IIIa(TSLS)	0.119	-0.027	-0.054		-0.017	0.186								0.51	38
	(0.51)	(-4.04)	(-2.26)		(-2.57)	(1.99)								0.45	
IV	0.025	-0.019	-0.054	-0.027	-0.010					-0.015	-0.006	0.016	0.035	0.60	38
	(1.87)	(-3.17)	(-2.03)	(-0.75)	(-1.51)					(-0.71)	(-2.35)	(1.69)	(2.26)	0.49	
IVa. (Financial dummy replaced with real interest rate)	0.027	-0.018	-0.049	-0.033	.0006					-0.021	-0.006	0.015	0.036	.63	38
	(2.01)	(-3.37)	(-1.93)	(-0.90)	(2.44)					(-1.07)	(-2.75)	(1.75)	(2.41)	.52	
V	0.031	0.032	-0.119		-0.022		0.012	0.066						0.57	38
	(6.83)	(-2.39)	(-3.54)		(-2.12)		(0.77)	(1.68)						0.50	
VI	0.032	-0.018	-0.073		-.014				-0.013					0.50	38
	(5.22)	(-0.10)	(-2.14)		(-2.05)				(-0.46)					0.44	
VII	0.040			-0.088	-0.018					-0.030				0.42	51
	(6.47)			(-3.17)	(-2.48)					(-2.86)				0.38	
VIIa (FDUM < -2)	.040			-0.081	-0.011					-.037				0.38	51
	(6.35)			(-3.00)	(-1.83)					(-3.47)				0.34	

Note: In Regression IIIa, investment is instrumented with the other right-hand side variables, a dummy for being an oil producer, continent dummies for Africa and Latin America, and population size. In regression IVa, the financial repression dummy (=1 if real interest rate<-5) is replaced by the real interest rate itself. In regression VIIa, the financial repression dummy is defined as 1 if the real interest rate < -2.

T-Statistics in parentheses

All results reported using White heteroskedasticity - consistent covariance matrices

Table 2 Variable definitions:

Average input price: Expenditure-weighted average across categories of inputs and investment goods listed in Appendix III for 1980 orthogonalized log of dollar price relative to the U.S.

Variance of input prices: Expenditure weighted variance across input and investment good categories for 1980 orthogonalized log of dollar price relative to the US.

Government consumption: Summers and Heston ratio of real government consumption to GDP, 1970-85 (Barro variable HSGOV)

Financial repression dummy: 1 if country has average real interest rate for 1970-85 less than -5 percent, 0 otherwise (periods of average may vary depending on data availability) [From Gelb (1989) and World Bank data] In regression IVa, the dummy variable is replaced by the actual average real interest rate over 1970-85 (notice interpretation of the sign of coefficient will be reversed); in regression VIIa, the dummy variable is replaced by a dummy variable where the dummy is equal to one if the average real interest rate is less than -2 over 1970-85

Total investment: Summers and Heston ratio of real investment to GDP (Barro variable HSINV)

Mean consumption price: Expenditure-weighted average across categories of consumption goods listed in Appendix II for 1980 orthogonalized log of dollar price relative to the U.S.

Variance of consumption price: Expenditure-weighted variance across categories of consumption goods for 1980 orthogonalized log of dollar price relative to the U.S.

Mean of equipment price: Expenditure-weighted average across categories of equipment investment for 1980 orthogonalized log of dollar price relative to the U.S.

Black market premium: Log of ratio of black market to official exchange rate [World Bank data]

Initial income: Summers and Heston real per capita GDP in 1960 (Barro variable GDP60)

Primary enrollment: Barro variable PRIM60

Secondary enrollment: Barro variable SEC60

Note: orthogonalization is with respect to log of per capita income.

When we add the analogous measures of the mean and cross-commodity variance of consumption good prices, we find that they are insignificant, while the mean and variance of input prices continue to be significant (regression V). This is consistent with the prediction of the model that consumption price distortions do not matter but input price distortions do.[11]

The significance of the mean and variance of input prices is robust to the inclusion of correlates reported by Barro (regression IV). The same cannot be said for the financial repression dummy, whose significance is weakened when the Barro correlates are added.

We also examine the robustness of the result on the financial repression variable by considering alternative definitions of "repression". Redefining repression as less than a -2 percent real rate of interest increases the number of repression cases from 11 to 19 countries in the sample of 51 (regression VIIa). The redefined repression variable has the same sign but generally falls short of significance. On the other hand, a continuous variable for the real interest rate is still significant at roughly the same or higher level as the current dummy variable. The continuous variable retains significance in the Barro regression (regression IVa). Note that because of the redefinition of the variable, the sign here is the opposite of the dummy variable but still has the interpretation that negative real interest rates are bad for growth. The continuous variable may be more likely than the dummy variable to capture other sources of variation than just the degree of financial repression, however. We conclude the evidence for effects of financial distortions on growth is suggestive, but far from conclusive.

There is some evidence for effects of other distortion variables on growth. The black market premium is significant in an equation with financial repression and government spending (regression VII), but its significance disappears when the mean and variance of relative input prices (and the

[11]We also tried Dollar's (1992) measure of exchange rate overvaluation, which is closely related to the mean consumption price, and found it to be insignificant.

Barro correlates) are added (regression IV). The same is true for the share of government, whose significance also disappears when investment is added (regression II).

The strongest results are those for the new measures of price distortion. The results can be illustrated by looking at three data points: Chile, Korea, and Zambia, using regression III as the benchmark. All three had roughly the same investment rates, around 27 percent of GDP, but Korea had high growth (6%) and Chile (0%) and Zambia (-2%) had low growth. A significant portion of the difference in growth rates can be explained by regression III. Chile and Zambia both had high negative real interest rates (in Chile's case, mainly during the 70-73 Allende regime and its aftermath), which itself lowers growth by 1.6 percentage points. Korea and Chile both implicitly subsidized input investment goods heavily on average, while Zambia implicitly taxed them -- this explains over 2 percentage points of Zambia's lower growth compared to Korea. On the other hand, while Korea and Zambia only had moderately distorted prices between types of inputs, Chile's were heavily distorted. The high variance of input prices cost Chile 1.6 percentage points of growth compared to Korea. It is interesting that Korea was not a case of "getting prices right", but rather one of heavy subsidization of inputs, which implies growth was "too high" by about one and a half percentage points if no externalities are assumed.

V. CONCLUSIONS

A simple model of endogenous growth with two types of capital shows that distortions of relative input prices can have large effects on growth and welfare. The magnitude of the effect depends on the production elasticity of substitution. With high substitutability, the effects on growth and welfare are bounded -- albeit possibly large -- no matter how high the rate of distortion. Subsidization of inputs and investment goods can raise growth, even though they worsen welfare. But a subsidy to one capital good financed by a tax on another capital good unambiguously lowers

growth. Empirical results show strong negative effects of the variance of relative prices of investment goods across sector, while also confirming and extending earlier results that penalizing investment goods and distorting financial markets lowers growth.

APPENDIX I: effect on growth of a self-financing subsidy-cum-tax policy

As outlined in the text, an increase in a subsidy to type II capital financed by an increased tax rate on type I capital always lowers growth. To show this, it is sufficient to show that the tax increase necessary to finance the increased subsidy is greater than the tax increase that would just maintain the growth rate fixed (since a tax increase by itself unambiguously lowers growth). From (11) and (12) in the text, the balanced budget requirement means that s and τ must satisfy:

$$(A.1) \quad \frac{\tau}{s} = \left[\left(\frac{1-\gamma}{\gamma}\right)\left(\frac{1+\tau}{1-s}\right)\right]^{\frac{1}{1-\epsilon}}$$

The derivative of τ with respect to s from (A.1) (using (A.1) itself to simplify) is:

$$(A.2) \quad \frac{d\tau}{ds} = \frac{\frac{\tau}{s} + \left(\frac{1}{1-\epsilon}\right)\left(\frac{\tau}{1-s}\right)}{1 - \left(\frac{1}{1-\epsilon}\right)\left(\frac{\tau}{1+\tau}\right)}$$

Note that if $\epsilon > 0$ (elasticity of substitution > 1), then as the tax rate approaches $(1-\epsilon)/\epsilon$, the further increase in tax rate necessary to finance the subsidy goes to infinity. With elastic substitution possibilities, there is a limit on the subsidy rate that is feasible under a subsidy-cum-tax scheme. If $\epsilon \leq 0$, then any subsidy rate less than one is financeable.

From (3) in the text, the combination of τ and s that yield a constant growth rate g is given by:

$$(A.3) \quad \frac{r_2}{1-s}\left\{\frac{k_2}{k_1}(\tau, s)\right\} = \delta + \rho + \sigma g$$

where the {} denotes "function of ". The right-hand side of (A.3) is constant by assumption; g is the growth rate consistent with the initial τ and s. The derivative of τ with respect to s from (A.3) can be radically simplified to:

$$(A.4) \quad \frac{d\tau}{ds} = \frac{\tau}{s}$$

where we use the fact that $\frac{k_2}{k^1} = \tau/s$ at the initial point. Comparing the derivatives in (A.2) and (A.4), we see that (A.2) is unambiguously larger. This says that the tax increase necessary to raise the revenue to finance a given subsidy rate increase is larger than the tax rate increase that would just maintain the growth rate constant. Since an increase in the tax rate for a given rate of subsidy always lowers growth, this says that an increase in the subsidy rate on type II capital financed by an increase in the tax rate on type I capital unambiguously lowers growth.

Appendix II Measures of distortion by country

Country Code	Dummy for real interest rate < -5 percent	Variance of log input prices across commodities	Average of log input price
ARG	1.0000	0.30540	0.11346
AUS	0.0000		
AUT	0.0000	0.11637	0.21361
BEL	0.0000	0.08437	0.13862
BGD	0.0000		
BOL	1.0000	0.48855	-0.60131
BRA	0.0000	0.20190	-0.63741
BWA		0.29419	-0.37146
CAN	0.0000	0.20076	-0.12823
CHL	1.0000	0.44598	-0.69260
CIV	0.0000	0.24375	0.61117
CMR		0.23439	0.34927
COL	0.0000	0.27456	-0.86938
CRI		0.28177	-0.56820
DEU	0.0000	0.08263	0.21025
DNK	0.0000	0.08669	0.22302
DOM		0.27763	-0.57177
ECU	1.0000	0.26691	-0.68048
EGY			
ESP	0.0000	0.10180	-0.07460
ETH		0.09136	-0.30319
FIN	0.0000	0.18841	-0.13398
FRA	0.0000	0.08534	0.16782
GBR	0.0000	0.09592	0.14543
GHA	1.0000		
GRC	0.0000	0.11019	-0.10670
GTM		0.25984	-0.75592
HKG		0.34041	-0.34221
HND	0.0000	0.21311	-0.49242
HVO	0.0000		
IDN	0.0000	0.45054	-0.74011
IND	0.0000	0.26197	-0.83478
IRL	0.0000	0.08524	0.04370
ISR		0.18251	-0.26654
ITA	0.0000	0.06059	-0.11482
JAM	1.0000		
JPN	0.0000	0.27041	-0.15863
KEN	0.0000	0.12181	0.07898
KOR	0.0000	0.21275	-0.52395
LKA	0.0000	0.86055	-1.7395
LSO			
LUX		0.08205	0.07541
MAR	0.0000	0.26745	0.08155
MDG		0.23096	0.11406
MEX	1.0000		
MLI		0.08088	0.19531
MWI	0.0000	0.19747	-0.03904
MYS	0.0000		
NGA	1.0000	0.23055	0.36374
NLD	0.0000	0.08333	0.25131
NOR	0.0000	0.18860	0.16539
OMN	0.0000		
PAK	0.0000	0.38139	-1.2882
PAN		0.22161	-0.46406
PER	1.0000	0.53797	-0.95879
PHL	0.0000	0.36690	-0.89310
POL	1.0000		
PRT		0.10873	-0.32353
PRY		0.37157	-0.33605
SEN		0.13439	0.41137
SGP			
SLE	1.0000		
SLV		0.19866	-0.71495
SWE	0.0000		
THA	0.0000		
TTO	0.0000		
TUN		0.35756	-0.11056
TUR	1.0000		
TZA		0.32011	0.08463
URY		0.22126	-0.35478
USA	0.0000	0.04679	-0.04679
VEN	0.0000	0.75701	-0.51048
ZAR	1.0000		
ZMB	1.0000	0.28783	0.24166
ZWE	0.0000	0.22431	0.16105

Appendix III Goods for Calculation of consumption and input price averages and variances

Consumption Goods	Intermediate Inputs and Investment Goods
Rice	Drugs, medical preparations
Meal, other cereals	Medical supplies
Bread	Therapeutic equipment
Biscuits, cakes, etc.	Physicians' equipment
Cereal preparation	Dentists' services
Macaroni, spaghetti	Nurses' services
Fresh beef, veal	Hospitals
Fresh lamb, mutton	Personal automobiles
Fresh pork	Other personal transport
Fresh poultry	Tires, tubes, accessories
Other fresh meat	Automobile repairs
Frozen and salted meat	Gasoline, oil, grease
Fresh and frozen fish	Parking, tolls, etc.
Canned fish	Local transport
Fresh milk	Rail transport
Milk products	Bus transport
Eggs, egg products	Air transport
Butter	Postal communication
Margarine, edible oil	Telephone, telegraph
Lard, edible fat	Books, papers, magazines
Fresh tropical fruits	Stationery
Other fresh fruits	First and second-level teachers
Fresh vegetables	College teachers
Fruit other than fresh	Physical facilities for education
Vegetables other than fresh	Educational books, supplies
Tubers, including potatoes	Other educational expenditures
Coffee	Hotels
Tea	Industrial buildings
Cocoa	Commercial buildings
Sugar	Office buildings
Jam, syrup, honey	Educational buildings
Chocolate, ice cream	Hospital buildings
Salt, spices, sauces	Agricultural buildings
Non-alcoholic beverages	Other buildings
Spirits	Roads, streets, highways
Wine, cider	Transport and utility lines
Beer	Other construction
Cigarettes	Land improvement
Cigars, tobacco, snuff	Locomotives
Clothing materials	Other railway vehicles
Men's clothing	Passenger automobiles
Women's clothing	Trucks, buses, trailers
Boys' and girls' clothing	Aircraft
Men's and boys' underwear	Ships, boats
Women's and girls' underwear	Other transport equipment
Haberdashery, millinery	Engines, turbines
Clothing rental and repair	Tractors
Men's footwear	Other agricultural machinery
Women's footwear	Office machinery
Children's footwear	Metalworking machinery
Footwear, repairs	Construction, mining machinery
Furniture Fixtures	Special industrial machinery
Floor coverings	Electrical transmission equipment
Household textiles, etc.	Communications equipment
Refrigerators, freezers	Other electrical equipment
Washing appliances	Instruments
Cooking appliances	Furniture, fixtures
Heating appliances	Other durable goods
Cleaning appliances	
Other household appliances	
Household utensils	
Nondurable household goods	
Domestic services	
Household services	
Barber and beauty shops	
Toilet articles	
Other personal care goods	
Restaurants, cafes	
Hotels, lodgings	
Other services	
Expenditures of residents abroad	
One and two-family dwellings	
Multifamily dwellings	

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Figure 1: Distortionary Tax Rates and Growth (Alternative Elasticities of Substitution in Production)

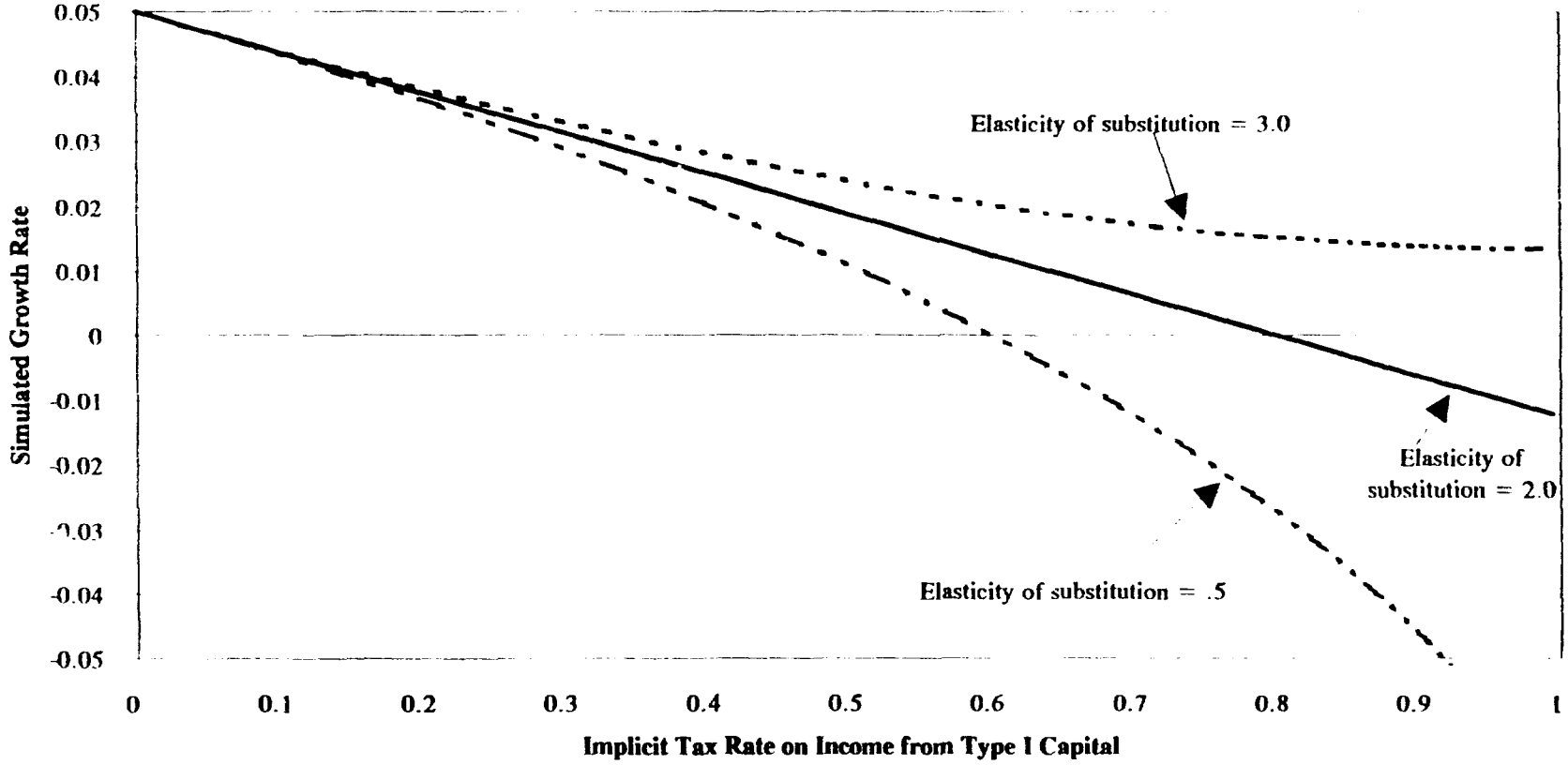
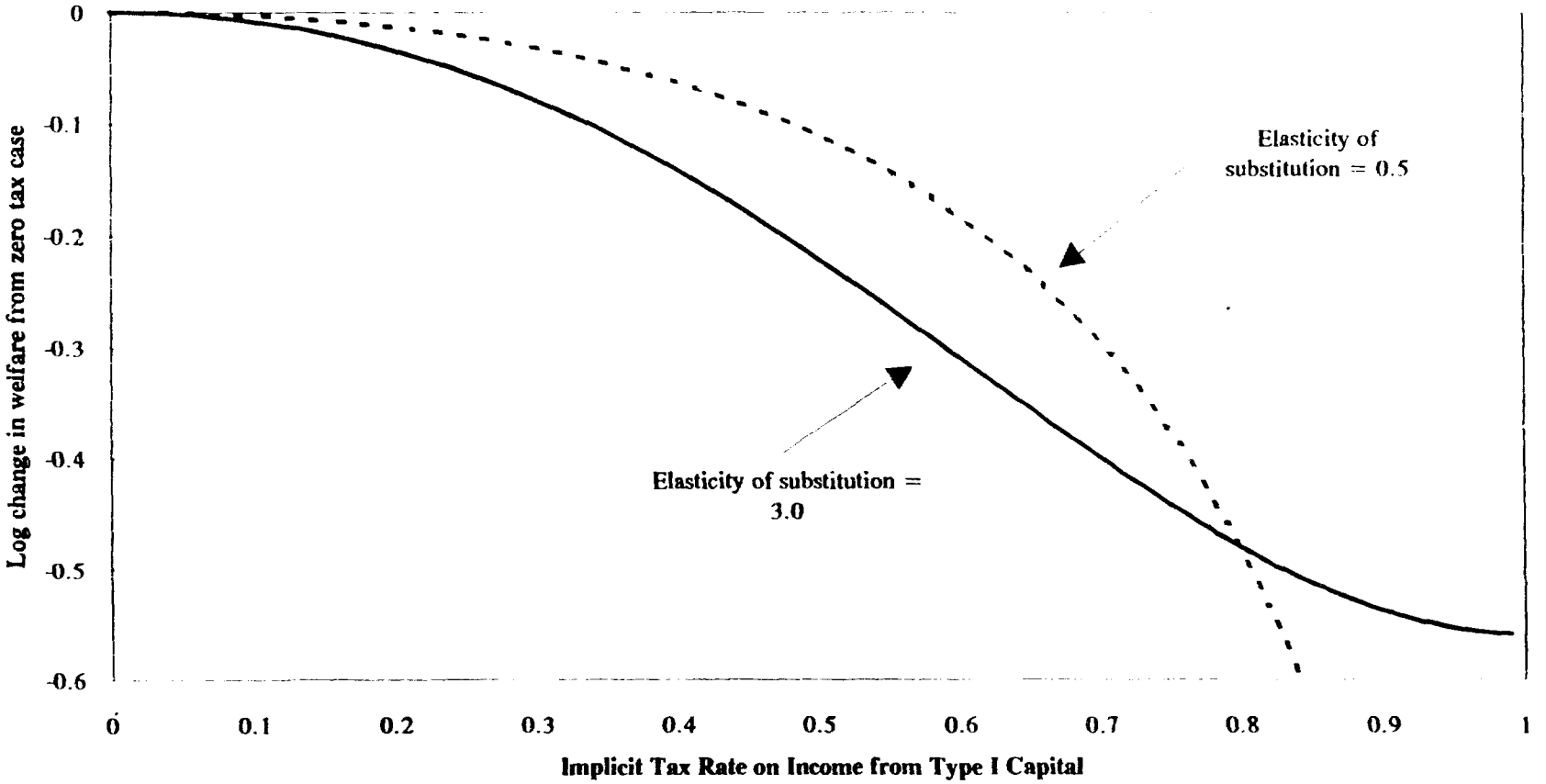


Figure 2: Welfare and distortion (Alternative elasticities of substitution in production)



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